**Chapter 5: Changes Around Us: Physical and Chemical**

**1. Introduction to the Changing World**

- **Constant Transformation:** Our environment is never static; changes happen continuously around us every single day.
- **Everyday Observations:** The chapter begins by highlighting simple, observable changes:
    - *State Change:* A solid cube of ice left on a table slowly melts into liquid water.
    - *Biological Growth:* A tiny green bud on a rose plant blossoms into a full, colourful flower overnight.
    - *Temperature Shift:* A chilled bottle of cold water gradually loses its coldness and reaches room temperature.
    - *Chemical Decay:* A banana with a few brown spots develops more spots the next day and emits a strong, distinct smell.
- **The Role of Our Senses:** We are able to observe and categorize these physical, structural, and chemical changes using our five primary senses: sight, smell, touch, hearing, and taste.

**2. Physical Changes (Appearance Alters, Substance Remains)**

A physical change alters the outward appearance of a material, but its fundamental identity remains intact.

**A. Defining a Physical Change**

- **Scientific Definition:** A physical change is a process in which only the physical properties of a substance—such as its shape, size, or state (solid, liquid, gas)—undergo a change.
- **The Golden Rule:** During a purely physical change, **no new substance is ever formed**.

**B. Experimental Proof (Activity 5.2)**

The textbook demonstrates physical changes through three distinct hands-on actions:

1. **Creating Origami (Paper Folding):** When you fold flat sheets of paper into new shapes like boats, birds, or butterflies, the size and shape change. However, if you unfold the objects, you get the exact same sheet of paper back. This is a **reversible physical change**.
2. **Playing with a Balloon:**

    - *Inflating and Deflating:* Blowing air into a balloon stretches the rubber, changing its size and shape. Releasing the air returns it to normal (reversible).
    - *Popping:* If you prick a tightly inflated balloon with a sharp pin, it violently bursts into pieces. You cannot get the original balloon back, making it **irreversible**, but it is *still* a physical change because the scattered pieces are still made of rubber (no new substance was created).
3. **Crushing a Piece of Chalk:** Grinding a solid stick of chalk into a fine powder drastically alters its physical form and size. You cannot easily mold the dry powder back into a solid stick (irreversible), but the powder is structurally still chalk.

**3. Chemical Changes (The Formation of New Substances)**

A chemical change alters the very identity of the materials involved, creating entirely new chemical entities.

**A. Defining a Chemical Change**

- **Scientific Definition:** A chemical change is a process in which one or more entirely **new substances are formed**.
- **The Mechanism:** These new substances are produced through a process formally known as a **chemical reaction**, which can be written out as a chemical equation.

**B. The Lime Water Experiment (Activity 5.3)**

- **The Setup:** Two glass tumblers are taken: Tumbler 'A' contains plain tap water, and Tumbler 'B' contains clear lime water.
- **The Action:** A student uses a straw to blow exhaled air into both tumblers.
- **The Result:** In Tumbler A (tap water), only temporary bubbles form, and the water's appearance remains unchanged. However, in Tumbler B, the clear lime water suddenly turns **milky (cloudy)**. If left undisturbed, a white powdery substance settles at the bottom of the glass.
- **The Science:** The human breath contains carbon dioxide gas. When this gas mixes with lime water, a chemical reaction occurs, forming a new, water-insoluble white substance called **calcium carbonate**.
- **The Chemical Word Equation:** $\text{Calcium hydroxide (Lime water)} + \text{Carbon dioxide} \rightarrow \text{Calcium carbonate (Insoluble substance)} + \text{Water}$.

**C. The Vinegar and Baking Soda Reaction (Activity 5.4)**

- **The Action:** A teaspoonful of vinegar (an acid) is placed in a test tube, and a pinch of baking soda (sodium hydrogen carbonate, a base) is added.
- **The Observation:** Immediately, a loud fizzing, bubbling sound is heard, and gas bubbles rapidly rise to the surface.
- **Testing the Gas:** To identify the invisible gas, it is passed through a delivery tube into a second test tube containing freshly prepared lime water. The lime water instantly turns milky.
- **Conclusion:** The milkiness confirms that the violent fizzing reaction produced **carbon dioxide gas** as a new substance, proving a chemical change occurred.
- **The Chemical Word Equation:** $\text{Vinegar} + \text{Baking soda} \rightarrow \text{Carbon dioxide} + \text{Other substances}$.

**4. Specific Types of Chemical Changes**

**A. Rusting**

- When iron is exposed to moisture and air over time, it develops a flaky, brown-coloured coating on its surface.
- This is a chemical change because the original iron reacts to form a completely new chemical compound called **rust (iron oxide)**.

**B. Combustion (Burning)**

- **Burning Magnesium (Recap):** When a strip of magnesium ribbon is held over a flame, it burns with a blinding white light. The metal ribbon is destroyed, leaving behind a crumbly white powder.
- **The Chemical Word Equation:** $\text{Magnesium (Ribbon)} + \text{Oxygen (Air)} \rightarrow \text{Magnesium oxide (White powder)} + \text{Heat} + \text{Light}$.
- **Definition of Combustion:** A chemical reaction in which a combustible substance (fuel) reacts violently with oxygen in the air, producing heat and/or light. Examples of combustible fuels include wood, paper, cotton, and kerosene.

**5. The Fire Triangle: The Three Rules of Combustion**

For a fire (combustion) to start and survive, exactly three elements must be present simultaneously. If any one is removed, the fire dies.

1. **Fuel (A Combustible Substance):** You need a material that can actually burn (like paper or wood).
2. **Oxygen (Air Supply - Activity 5.5):**

- *The Proof:* If two candles are lit and a glass tumbler is placed over one of them, the covered candle will flicker and die after a few seconds, while the uncovered one continues to burn.
- *The Reason:* The glass tumbler cuts off the continuous supply of fresh air (oxygen). Without oxygen, combustion is impossible.

3. **Heat (Reaching Ignition Temperature - Activity 5.6):**
    - *The Concept:* Paper is fuel and sits surrounded by oxygen all day, yet it does not spontaneously catch fire. It requires a trigger.
    - *The Proof:* Using a magnifying glass to sharply focus intense sunrays into a tiny, bright dot on a piece of paper causes the paper to heat up. Soon, it emits smoke and catches fire, even without a matchstick.
    - *Ignition Temperature:* This is defined as the absolute **minimum temperature** at which a specific substance catches fire. A matchstick works because its flame is hotter than the paper's ignition temperature.

**Science and Society (Fire Safety):** If a person's clothing catches fire, the immediate, most effective scientific response is to tightly wrap a heavy blanket or cloth around them. This breaks the "Fire Triangle" by physically cutting off the oxygen supply, extinguishing the flames. *Crucial Warning:* Never use a synthetic blanket, as the intense heat will melt the plastic fibres, causing them to fuse agonizingly to the victim's skin.

**Fascinating Fact (Bioluminescence):** Fireflies (lightning bugs) emit a magical glow in the dark. This is driven by a unique chemical change inside their bodies that produces pure light *without* producing any heat, a rare natural phenomenon called **bioluminescence**.

**6. The Candle Paradox: Physical and Chemical Changes Together**

Can both types of changes happen simultaneously in the exact same object? Yes.

- **Activity 5.7 (Analyzing a Burning Candle):**
    - **The Physical Changes:** As the flame burns, the solid wax heats up and **melts** into a liquid pool. This liquid wax is drawn up the wick and evaporates into a gas. Any dripping liquid wax eventually cools and **solidifies** back into solid wax. Melting, evaporating, and solidifying are all purely physical state changes.
    - **The Chemical Change:** The actual *burning* of the hot wax vapour at the wick, which produces carbon dioxide, heat, and a bright flame, is a permanent chemical change.

- **Michael Faraday's Contribution:** In the 19th century, the legendary scientist Michael Faraday delivered a famous series of lectures titled *"The Chemical History of a Candle"* because he believed a simple candle was the ultimate, perfect object to explain complex physical and chemical processes like melting, vaporization, and combustion.

**7. Evaluating Changes: Reversibility and Desirability**

**A. Reversibility (Activity 5.8)**

- **Reversible Changes:** We can return the object to its original state. *Examples:* Melting ice cubes (can be refrozen) and boiling water (steam can be condensed back into liquid).
- **Irreversible Changes:** The original state is lost forever. *Examples:* Chopping vegetables, making popcorn from hard corn kernels, and stitching cloth into a shirt. *Note:* While many physical changes (like folding paper) are reversible, cutting paper or crushing chalk are physical changes that are irreversible.

**B. Desirability**

- **Desirable Changes:** Useful modifications that benefit daily life, such as milk turning into thick curd, fruits ripening to become sweet, and cooking raw ingredients into digestible food.
- **Undesirable Changes:** Destructive modifications like the rusting of iron tools or the foul decay of stored food.
- **Contextual Desirability:** A change can be bad in one context but amazing in another. Rotting food is terrible in a refrigerator, but the bacterial decomposition of food waste into nutrient-rich garden compost is highly desirable.
- **Environmental Impact:** Changes driven by human activity can be severely undesirable on a global scale. The combustion of fossil fuels in cars and planes releases massive amounts of carbon dioxide, causing global warming. Even the simple drying of wet paint on walls releases evaporated chemical substances that cause atmospheric pollution.

**8. Slow Natural Changes: Sculpting the Earth**

The Earth's surface is constantly being reshaped by massive, agonizingly slow physical and chemical changes that take thousands of years.

**A. Weathering of Rocks**

Weathering is the process that breaks down giant mountain rocks into smaller sediments, eventually forming soil.

- **Physical Weathering:** Massive rocks are physically cracked and shattered by extreme temperature shifts, the powerful expanding roots of growing trees, and the freezing/expanding of trapped water inside rock crevices.
- **Chemical Weathering:** Water, and the natural chemicals dissolved within it, react chemically with the minerals inside rocks. *Example:* Basalt is a stark black rock that contains iron. Over centuries of exposure to air and water vapour, the iron chemically oxidizes (rusts), turning the surface of the rock into a striking red layer of iron oxide.

**B. Erosion**

- **The Process:** Once weathering breaks rocks into fine sand, pebbles, and sediments, these materials are forcefully picked up and moved to entirely new locations by the natural power of wind and flowing river water. This physical transportation is called **erosion**.
- **The Results:** Erosion by rushing water acts like sandpaper, polishing rough, jagged rocks into perfectly smooth river pebbles. When rivers hit the calm waters of a lake or ocean, the water speed drops, and the carried sand settles to the bottom. Over thousands of years, these settled sediments compress and harden into entirely new layers of rock.

**9. Exploratory Science Projects**

The chapter encourages hands-on applications of physical and chemical principles:

1. **Invisible Ink (Chemical Oxidation):** Write a secret message on paper using pure lemon juice and let it dry completely, rendering it invisible. When you apply gentle heat (by running a warm iron over it or holding it safely above a candle flame), the acidic juice chemically oxidizes and burns faster than the paper, turning the invisible letters dark brown. This is an irreversible chemical change.
2. **Yeast Fermentation (Biological/Chemical Change):** Mix sugar, warm water, and a spoonful of live yeast inside a bottle, then securely stretch a rubber balloon over the mouth. Over an hour, the yeast feeds on the sugar (a chemical change known as fermentation) and releases massive amounts of carbon dioxide gas, which physically inflates the balloon. If this trapped gas is released into lime water, it turns the water milky, proving it is carbon dioxide.
3. **Animal Adaptation:** Chameleons (*Girgits*) undergo fascinating biological changes, shifting their skin colour to perfectly blend with their surroundings to hide from predators, or shifting colours when angry. This is a naturally reversible change.